The identification of trees in winter.

AUG. F. FOERSTE.

(WITH PLATES XII AND XIII.)

Any method of identifying ligneous plants other than the ordinary one by means of their flowers and leaves, must necessarily be very artificial. Under these circumstances it is important to use as a means of comparison those parts of ligneous plants which are certain to be present both in the young growth and in the fully matured plant, and which, during the various stages of development from the small sapling to the superannuated tree, show essentially the same characteristics. There is only one part of ligneous plants which approximately fulfills these conditions and that is the crop of little twigs added each year to the tips or the sides of the branches, with the petiole-scars from the last season's leaves and the subtended, more or less scaly, winter buds which enclose a portion or all of the growth of the coming season in rudimentary form.

As a matter of fact the length of these twigs varies considerably at different stages in the history of the same individual and even on different branches of the same tree or shrub during the same season; moreover the form and size of the petiole-scars and the scaly buds vary quite commonly on approaching the tips or the base of even the same twig. If, however, the length of a twig be left out of consideration, and only the larger petiole scars and scaly buds be made objects of comparison, the constancy of color and markings of the bark, of the character of the pith, of the form and structure of the petiole-scars, of the figures presented by the foliar fibrovascular bundles, and of the form and structure of the scaly buds, is very striking. This constancy of characteristics within the limits of the same species is supplemented by sufficient *variation* in the features presented by *different* species, to make it possible to use these characteristics in recognizing the genus of ligneous plants and, in the great majority of cases, also the species. The various characteristics presented by ligneous plants will be discussed in the order of the importance, thus providing at the same time a plan in accordance with which ligneous plants can be classified artificially so as to facilitate their identification.

I. The determination of the phyllotaxy of the leaves of the species examined, as shown by the petiole-scars remaining from last year's leaves, is the first step towards identification. It so happens that a classification of shrubs and trees into those with alternate, spiral, and opposite or whorled leaves gives rise to three fairly equal sets. The determination of the phyllotaxy of a plant at once excludes quite a large list of shrubs and trees with another kind of arrangement of leaves from the list of possibilities. The rarer phyllotaxies such as $\frac{1}{3}$ (*Spiræa opulifolia* Linn., fig. 13); $\frac{3}{8}$ (*Diospyros Virginiana* Linn.) and $\frac{2}{3}$ (*Catalpa speciosa* Warder) will of course make the identification of a ligneous plant still more easy. In certain species the phyllotaxy is occasionally or even quite regularly (*Castanea*) more or less variable in different twigs of the same tree, but these cases are sufficiently rare not to give any serious difficulty.

II. The form of the more fully developed petiole-scars and the mode of disposition of the fibrovascular bundles where intersected at the petiole-scar is the second important means of classifying ligneous plants. The following are some of the most important types:

1. In those petiole-scars where the outline is markedly rounded, the fibrovascular bundles are often arranged in a sort of circle within the scar (*Morus rubra* Linn., fig. 5; *Ampelopsis quinquefolia* Michx., fig. 6; *Celastrus scandens* Linn., fig. 8; *Rhus aromatica* Ait., fig. 16; and *Catalpa speciosa* Warder). Sometimes these bundles take the form rather of a circular area than of a circle.

2. In those petiole-scars which have a broadly circular form below but a square outline above, the fibrovascular bundles are often arranged in the form of a semicircle (*Euonymus atropurpureus* Jacq., fig. 19; species of *Fraxinus*).

3. In certain petiole-scars which are strongly horseshoe shaped the bundles form a series having approximately the same shape (*Ptelea trifoliata* Linn., *Rhus glabra* Linn., fig. 15; as variations of the last type, in species of *Fraxinus*). In the preceding three types the fibrovascular bundles are arranged in an approximately continuous series. In many other cases they form several distinct sets in the same scar.

4. Thus in certain scars, usually more or less heart shaped, these bundles form lunate sets, either in considerable number

(*Ailanthus glandulosus* Desf.) or only with three in each scar (species of *Juglans*, *Pterocarya*, *Carya*, figs. 20–30.

5. In other scars of heart-shaped form, and in the great majority of those which are lunate, the fibrovascular bundles form small circular areas. These show a sufficient constancy in their number within the same scar if only the more fully developed scars be examined and if quite a number of twigs be drawn into consideration, so that a division into scars with only three sets (*Ulmus fulva*, Michx., fig. 3; *Celtis occidentalis* Linn., fig. 4; *Viburnum molle*, fig. 10; *Nyssa multiflora* Wang., fig. 11; *Spiraea opulifolia* Linn., fig. 13; *Hamamelis Virginica* Linn.), and into scars having five rounded sets of fibrovascular bundles is possible (*Asimina triloba* Dunal., fig. 1; *Rhus Toxicodendron* Linn., fig. 7; species of *Æsculus*). Sometimes these sets, normally five, are reduced to three in all the smaller scars, or on the weaker twigs. In other species the number usually five is occasionally raised to seven (*Sambucus Canadensis* Linn., fig. 37). The two outer sets are often more or less approximated while the median fifth set is left more isolated (*Gymnocladus Canadensis* Lam., fig. 31; *Acer saccharinum* Wang.). How far this character remains constant and therefore of value for present purposes has not been determined.

In species with opposite leaves it is also frequently of assistance to notice if the edges of the petiole scars are sufficiently extended laterally almost or quite to meet (*Cornus florida* Linn., fig. 35; *Cornus paniculata* L'Her., fig. 36.; *Negundo aceroides*, Moench, fig, 18; *Acer saccharinum* Wang.) or if they remain considerably separated from each other (species of *Fraxinus*, *Euonymus atropurpureus* Jacq., fig. 19; species of *Æsculus*.)

III. A third means for further classifying ligneous plants is the character of their winter buds.

1. These may be so situated, either concealed in the substance of the petiole scar itself, or covered by the anterior end of the scar, that the development of these buds towards spring requires the splitting of the scar, or at least a very marked forcing back of the anterior end of the same (*Menispermum Canadense* Linn., fig. 12; *Robinia Pseudacacia* Linn., *Rhus aromatica* Ait., fig. 16.

2. At times the buds are sunk into the bark of the twigs,

but are not covered by the petiole-scars, the flattened tops of the buds scarcely rising above the level of the scar or of the bark of the twig (*Gymnocladus Canadensis* Lam., fig. 31; *Ptelea trifoliata* Linn.). The flattened buds of *Ailanthus glandulosus* Desf. would probably form a closely related class. The remaining more prominently developed scaly buds can be most conveniently classified into:

3. Those which show only one or two scales exteriorly, with perhaps a glimpse of a third or fourth scale but no more (*Smilax hispida* Muhl., fig. 9; *Liriodendron Tulipifera* Linn., fig. 14; *Rhus glabra* Linn., fig. 15; *Diospyros Virginiana* Linn.; *Cornus florida* Linn., fig. 35; *Cornus paniculata* L'Her., fig. 36; *Asimina triloba* Dunal, fig. 1; *Tilia Americana* Linn.; *Lindera Benzoin* Meissner, fig. 33); and

4. Those with typically four or more scales exposed exteriorly. This class can be further subdivided into, *a*, those in which the terminal buds are typically much larger than the lateral buds (*Asimina triloba* Dunal, fig. 21; *Sassafras officinale* Nees; species of *Fraxinus*; *Juglans*, figs. 21, 22; *Carya*, figs. 26–30; *Negundo aceroides* Moench, fig. 18); and, *b*, those in which such a difference if noticeable is not typically of a marked character. In the terminal buds of the first division the exterior scales not uncommonly give more or less evidence of their origin as transformations of leaves. In the cases in which, on dissecting the scaly bud, the scales, with the exception often of the first two, are seen to be evidently metamorphosed stipules (*Liriodendron Tulipifera* Linn., fig. 14; *Fagus ferruginea* Ait.; species of *Quercus*, *Castanea*, *Carpinus*, *Corylus*, and *Tilia*) the list of possibilities is still further reduced. The marked crowding together of buds towards the tips of the branches, as in species of *Quercus*, is often evident enough to be quite characteristic of certain species, but does not serve well as a basis for more general classification.

IV. The manner in which branches are terminated gives a fourth means of distinguishing ligneous plants.

1. Thus the green tips of the newly developing twigs are in certain species cast off each spring, and in the winter-twigs the absence of the terminal bud and the presence of a scar there where the bud ought to be, can always be readily recognized (*Tilia Americana* Linn.; *Catalpa speciosa* Warder;

Ailanthus glandulosus; *Ulmus fulva* Michx., fig. 3). While in many species all, or almost all, of the tips of the branches are thus affected, in others (species of *Æsculus*) only one half the tips of the branches are thus terminated, while the remainder show the usual terminal scaly buds.

2. In other species the tip of the branches shrivels up at a very early date, before summer, but is not cast off, the shriveled tip remaining through the winter (*Diospyros Virginiana* Linn.; species of lilac).

3. Again in other cases the tiny tips are not killed in early spring, but quite a considerable portion of the more developed branch is killed back by the frosts of autumn.

4. Lastly, in the great majority of species, terminal scaly buds are always present.

V. A fifth means of determining ligneous plants is often given by the presence or absence of stipules, as indicated by the scars which remain after they have fallen off. Since these stipules usually fall off early in spring they frequently leave but indistinct scars in witness of their former presence, but a little practice will make the observer quite adept in recognizing even the poorer stipule-scars on the winter twigs. The stipule-scars, when present, may more or less encircle the stem, (*Liriodendron Tulipifera* Linn., fig. 14, or may be considerably separated, as usual (*Tilia Americana* Linn.; *Fagus ferruginea* Ait., fig. 17; *Morus rubra* Linn., fig. 5; *Hamamelis Virginica* Linn.) In certain species the stipules are represented by thorns, as in *Robinia Pseudacacia* Linn., and *Xanthoxylum Americanum* Mill. When these stipular thorns are aborted, as occurs at times in the latter species, the fibrovascular bundles destined to provide them with sap can be detected at the surface of the wood on removing the bark. Most ligneous plants never have stipules.

VI. The presence of thorns in general often provides a sixth means of distinguishing plants. Thorns representing stipules have already been mentioned. They often also represent small axillary branches, usually supplemented by normal leaf buds at their base. The relative position and character of the thorns and leaf-buds is then at times a means of distinguishing species. Thus, in *Gleditschia triacanthos* Linn., the thorn represents the upper of a series of superposed bud, and is often decidedly removed from the subtending

leaf scar; the thorn is frequently branched, and its branches subtended by distinct bracts. In *Crataegus Crus-galli* Linn., the thorn has two lateral buds, of which one exceeds the other considerably in size. The smaller bud usually perishes, the larger one develops, pushes the thorn aside, and in the older parts of the tree the thorn then assumes an apparently lateral position. In *Maclura aurantiaca* Nuttall there is usually a leaf bud on one side, and a long narrow scale with empty axil on the other.

The fact that in certain species the thorns representing branches appear only under abnormal conditions, or first in the older plants, reduces the value of thorns as constant features in distinguishing plants. Many ligneous plants also have thorns which represent only outgrowths of the bark. These are usually irregular in their disposition, but the triple spines of *Ribes Cynosbati* Linn., placed just beneath the petiole-scar is a good instance of the constancy of character and disposition sometimes shown by mere outgrowths of the bark.

VII. A seventh characteristic of ligneous plants is the presence or absence of more or less salient ridges on the bark. These show usually some more or less definite relation to the petiole scars, being frequently decurrent from the latter (*Spiræa opulifolia* Linn., fig. 13; *Cercis Canadensis* Linn. fig. 2; *Euonymus atropurpureus* Jacq., fig. 19). The more or less rounded angles of other plants are also worthy at times of observation, as in the case of the frequently eight to ten-angled stems of *Sambucus Canadensis* Linn., fig. 37.

In addition to these more important characteristics furnished by the annual growth of twigs which can be used in forming a sort of artificial classification of plants, there are others which are very useful in distinguishing the individual species.

The color of the bark of twigs usually varies in shades of brown or gray. When therefore a tree or shrub presents characteristically twigs with bark of a green color (*Negundo aceroides* Moench, fig. 18; *Sassafras officinale* Nees; *Euonymus atropurpureus* Jacq., fig. 19) or of various shades of red or purple, the color becomes a characteristic feature of value. The genus *Cornus* provides a striking instance of the success with which the color of the annual twigs can often be used in

distinguishing species. The little circular ruptures in the bark of *Sambucus Canadensis* Linn., fig. 37; and the milky juice exuding from the broken bark of *Morus rubra* Linn., fig. 5, in warmer weather are also good characteristics.

Again, the pith at times affords good features. Thus in *Diospyros Virginiana* Linn., the place of the pith is usually hollow; in *Gymnocladus Canadensis* Linn., fig. 31, the pith is reddish brown; in species of *Juglans*, fig. 20, and *Pterocarya Caucasica* Kenell, fig. 23, there is a tendency for the pith to separate into transverse plates.

The more special examination of the form of the petiole scars with their intersected fibrovascular bundles, the relative size and form of the scaly buds, the number of scales visible exteriorly, their relative size and form, are features so widely variable in different species, and yet so nearly constant in individuals of the same species, that they furnish often the best means for specific determination. The various figures presented on the accompanying plates give a very good idea of the great importance of these features for specific or at least generic determination.

The preceding discussion will suffice to give an idea of the great variety of features offered by all annual twigs of ligneous plants for the purposes of their identification. For the great majority of such plants they will suffice in determining the species, and in almost all cases there is no difficulty about the genus. Naturally there will be the least difficulty in recognizing species during winter where the flora has been best studied during spring and summer by ordinary botanical methods, and where the range of possible species is therefore very well known.

In addition to these more omnipresent characteristics there are others which are very good if present. Such are for instance the form and character of the flowering buds for next year, whether present in the shape of naked catkins or flower buds or enclosed in more or less scaly buds (*Rhus aromatica* Ait.; *Asimina triloba* Dunal, fig. 1; *Cornus florida* Linn., fig. 35; *Cornus paniculata* L'Her., fig. 36; *Lindera Benzoin* Meissner, fig. 33). The presence of flower buds within the scaly winter buds is often indicated only by the larger size of those scaly buds which contain flower buds as compared with those which contain only rudimentary leaves. It

is evidently often possible to dissect the buds and to make a careful study of the leaves and inflorescence of many species of ligneous plants and at times even of the flowers destined to blossom next year. In other words the ordinary means of botanical determination can to a certain extent be employed. As a matter of practice, however, this was rarely found necessary since the external features were found sufficient for purposes of identification.

The remains of the inflorescence of the last season is another good means of recognizing ligneous plants when this is present, as in the case of the fruited pedicels of *Diospyros Virginiana* Linn., the inflorescence of *Ptelea trifoliata* Linn., *Rhus glabra* Linn., *Ostrya Virginica* Willd., *Cornus florida* Linn. At times even the fruit remains for a large part of the winter, or is found immediately beneath the tree where it has fallen on the ground. The pods of *Hamamelis Virginica* Linn., naturally remain on the tree all winter since they do not ripen until next year.

The bark of the trees usually finds difficulty in accommodating itself to the increased circumference of the tree in its old age, so that it often provides good characteristics at that time for distinguishing species. Thus in the beech the bark remains comparatively smooth; in the sycamore it splits off in flat little pieces; in species of hickory it separates in long shaggy strips which remain more or less attached to the tree; in species of birch the bark separates into more or less thin sheets which wrap horizontally around the trunk of the tree and fall off at times. In the great majority of trees the bark cracks more or less in advanced age and the peculiar cracks thus caused form often very characteristic figures or designs—if this expression be given not too literal a sense—which can be used in recognizing the genera and at times even the species of trees. Old woodsmen use this means of identifying the older trees often with considerable success, although often mistaken in determinations of the younger intermediate trees of the same species in which the cracks are less developed.

And lastly the general habits of a ligneous plant, whether it be a vine or not, the curvature of its branches, and the like often give good characteristics, although the general aspect produced by the method of branching in a young individual and in an old tree may be very different (*Ulmus*).

Of course it must not be expected that winter twigs with their scars and buds will furnish better means of distinguishing closely related species than the ordinary botanical ones. On the contrary they are apt not to be so good. It is very astonishing, however, how successful a means of recognizing species these annual twigs can provide. Thus where species although placed in the same genus show very marked botanical differences in their inflorescence, flowers, and leaves, the characters provided by the winter buds are usually also very well marked. For this purpose the figures here given of the several species of the *Rhus* are very significant—*Rhus glabra* Linn., fig. 15, with its remains of last year's inflorescence; *Rhus aromatica* Ait., fig. 16, with its spikes for next year's blossoming; and *Rhus Toxicodendron* Linn., fig. 7. The figures given of *Cornus florida* Linn., fig. 35, and *Cornus paniculata*, L'Her., fig. 36, are also very suggestive.

On the other hand when the species are more closely related to each other there is greater difficulty in recognizing the species. And yet even then it will be seen that in proportion as the species are found to be more closely related to each other according to ordinary methods of botanical determination, they will also show greater resemblance in the characters presented by the annual twigs. The various species of walnut and hickory show this fact very well as can be seen from the accompanying figs. 20—30, which represent most of the known species. Of course in the case of the willow, where the species are distinguished often by slight characteristics, many of the species can be identified in winter only by the expert, by means of slight characteristics often beyond the power of accurate description. Any one however who will take a glance at the accompanying plates, which present with the exception of a few *Juglandaceæ* only the commoner species from the vicinity of Dayton, Ohio, arbitrarily selected for illustration, will be struck by the facility with which the various species can be recognized. Moreover it will also be seen that even the ordinary observer without botanical training can soon learn to distinguish the various species of his district during winter if he have drawings of typical annual twigs of the various species as a means of comparison.

There are in many states botanical institutions founded for

the purpose of giving practical assistance to people of that state on questions relating to botany, especially questions of practical utility. It certainly seems as though a ready means of distinguishing the ligneous plants of their states would not be the most unwelcome contribution which these institutions could make to the people if the writer can judge from the interest usually awakened among farmers and woodsmen on showing them the various means of readily recognizing the species in winter.

It is therefore believed that the preparation of a set of plates with typical figures of the annual twigs, their scars and buds, of the ligneous plants of different states, would at present be a desideratum, especially if accompanied by critical notes indicating the range of variations within the limits of the same species, and a statement of those characteristics which are most significant in the identification of each species.[1]

In any case the above notes may serve to indicate what features have been found serviceable in the identification of ligneous plants in the winter months during ten years experience and what are their relative importance. Possibly it may also lead some to take an interest in the winter condition of plants who have hitherto confined most of their botanical work to the spring and summer.

Hotel des Thermes, Paris.

Explanation of plates.

The superposed buds are numbered in the order of their appearance and development by Roman numerals. In *Liriodendron*, fig. 14, *s* indicates the point of juncture of the leaf proper with the sheath formed by the stipules. On the exterior sheaths the leaf itself is represented only by a scar. In *Fagus*, fig. 17, *l* indicates the hairy leaf found after the exterior scales have been removed. The two scales on either side are the stipules for this leaf. The figures, except fig. 32, were all prepared in 1883. The date at which they were collected is indicated in each case in abbreviated form. The phyllotaxy is also given, in the form of a fraction. These figures have been chosen because from the large amount of material at hand, *these* have been found to be the most typical also for subsequent years.

Plate XII.— 1. Asimina triloba Dunal. *c*. Flower bud. 2. Cercis Canadensis L. 3. Ulmus fulva Michx. *b*, bud subtended by two leaf scars, the latter representing but one leaf in the phyllotaxy; see fig. 32. 4. Celtis occidentalis L. 5. Morus rubra L. 6. Ampelopsis quinquefolia Michx. 7. Rhus Toxicodendron L. Notice how readily this species is distinguished from the last in the winter. 8. Celastrus scandens L. 9. Smilax hispida Muhl. *b*, the bud in the

[1] Just such a work as is here suggested has been in preparation for a number of years by one of our ablest botanists. We have recently inspected the drawings which are nearly completed, and the work will be ready for publication within a few years at most.—Eds.

leaf axil seen from above. *c*, a section of the bud to show the ½ phyllotaxy. 10. Viburnum molle Mx. 11. Nyssa multiflora Wang. 12. Menispermum Canadense L. 13. Spiræa opulifolia L. 14. Liriodendron Tulipifera L. *b*, one of the inner stipular sheaths of the winter bud showing a young leaf attached. 15. Rhus glabra L. 16. Rhus aromatica Ait. 17. Fagus ferruginea Ait. *b*, a bud with several scales removed. 18. Negundo aceroides Mœnch. 19. Euonymus atropurpureus Jacq.

Plate XIII.—20. Juglans regia L. Scales of terminal bud less leafy than in other species. 21. Juglans nigra L. Buds close to the axils. 22. Juglans cinerea L. Buds usually a short distance above the axil. *b*. A scale of terminal bud. 23. Pterocarya Caucasica Kenell. Peculiar leaf scar. 24. Carya amara Nuttall. Slender buds near the axil. In Carya the figures made by the fibrovascular bundles are less distinct than in Juglans and often less distinct than here figured. 25. Carya olivaeformis Nuttall. Upper of the superposed buds often remote from the axil. 26. Carya porcina. This and the following species are forms intermediate between the two preceding species with more slender buds and the three following with more oval buds. 27. Carya microcarpa Nutt. 28. Carya tomentosa Nutt. To be distinguished from the next species by its more or less tomentose bark. A few scales have fallen off from the bud. 29. Carya alba Nutt. After a few scales have fallen off from the bud. 30. Carya sulcata Nuttall. Buds often clustered at the tip, outer scales with a close appressed pubescence; color, purplish brown, grading to greenish brown. 31. Gymnocladus Canadensis Lam. 32. Fraxinus excelsior L. From the Trocadero Gardens at Paris. Two buds in one axil. A single bud in the opposite axil, not seen. It is not a case of superposed buds, nor of one bud in the axil of the outer scale of the other, but a case of dédoublement. It is the opposite of that shown in fig. 3, *b*. 33. Lindera Benzoin Meissner. 34. Fraxinus. Species unknown, but both of them believed to belong to Fraxinus Americana. To show variation of scars, which is often great in species of this genus. 35. Cornus florida Linn. *a*, flower bud. Notice setting of buds in the tip of the stem; also in *b*, and compare with next species. 36. Cornus paniculata L'Her. *a*, flower bud. 37. Sambucus Canadensis L. The lower of the superposed buds, in a longitudinal section of the stem is seen to have its fibrovascular bundles connected at the base with those of the larger upper bud. These fibrovascular bundles of the lower bud are bent *backwards* from the above mentioned point of junction, in order to reach the smaller bud; this has not been noticed in the case of the other superposed buds examined, where the fibro-vascular bundles are all directed forward.

Two new genera of Hyphomycetes.

A. P. MORGAN.

The following genera of the Mucedineæ or white molds I have had so long and they appear so distinct that I may now venture upon their publication. The first is the only genus of the Didymosporæ in Saccardo's system possessing cylindric spores. The second by its remarkable spores represents a section Dictyosporæ, which is not represented in the Mucedineæ of Saccardo's volume.